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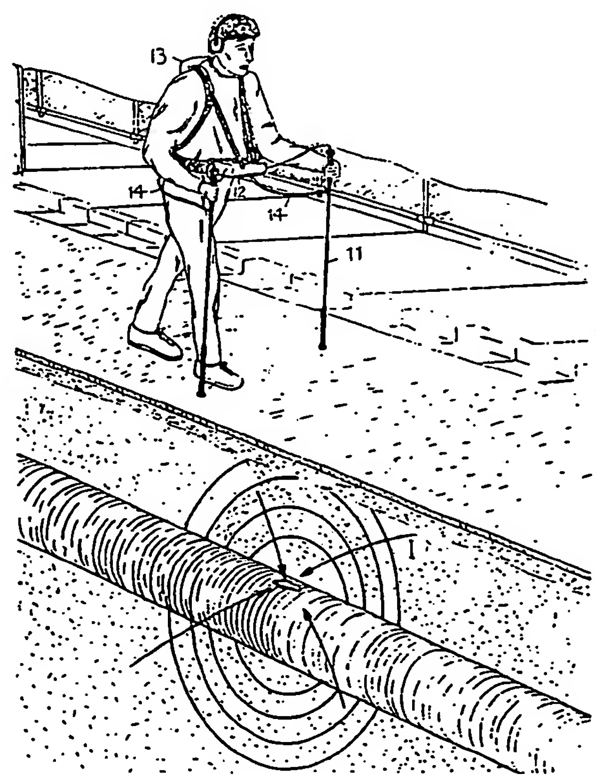
(54) Title: PIPELINE COATING SURVEY EQUIPMENT

(57) Abstract

D.C. voltage gradient ground level survey equipment for detecting protective coating defects in an underground pipeline beneath high resistance ground (such as bitumen/asphalt surfaces) has a pair of hand-held probe poles (11) with non-polarizing electrodes for measuring in-ground signals created by an injected pulsed signal; the probe poles are placed on the ground above the pipeline and are electrically and operatively connected to a receiver (12) carried by an operant; the poles being connected to a water reservoir carried in a back pack (13) worn by the operant by a water path (14) so that water is conveyed to pole tips which also have a grounding spike of stainless steel attached to increase conductivity when the probes are in contact with the ground; the amount of water conveyed to the pole tips is regulated by a hand valve in a tubing below the back pack (13) reservoir; a microswitch is installed in spring loaded handles of the poles (11) so that a voltmeter is de-activated whenever the poles are lifted up off the ground.



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PIPELINE COATING SURVEY EQUIPMENT

This invention relates generally to apparatus for locating areas of damaged protective coating on buried pipelines and relate more particularly to D.C. voltage gradient measuring apparatus with a increased ground contact conductivity facility for use with pipelines under concrete, dry ground and specifically under bitumen/asphalt.

Conventional A.C. type equipment previously used to detect coating defects on buried pipelines is not reliable due to problems of high ground probe contact resistance and changes in soil conductivity giving false readings. Later, developed D.C. type equipment has improved the quality of survey results, but it is prone to difficulties when surveying in areas of stray current interference, dry desert, over concrete and bitumen/asphalt roads, problems of static interference. Unstable readings and poor probe contact are experienced. Operator fatigue is also a problem when surveying long pipelines. Pipe maintenance is costly and pipeline exterior protective coatings break down in time and repairs such as re-wrapping are difficult and costly.

It is an object of this invention to provide measuring apparatus for break down in exterior protective coatings of underground pipelines, particularly those under dry surfaces and under bitumen/asphalt.

According to the present invention, there is provided apparatus for detecting protective coating defects in underground pipelines, cables or the like, buried under high resistance ground, the apparatus comprising a pair of hand probes for measuring signals in ground, created by an injected, pulsed signal applied thereto, the probes being adapted to be placed by an operator on the ground above and on either side of said pipeline, cable or the like, the probes being electrically operatively connected to a receiver and being fluidly connected to a reservoir containing an electrically conductive fluid fed to each probe via a water path, whereby the electrically conductive

fluid is conveyed onto the probe tips to increase the conductivity thereof, when the probes are in contact with the ground.

Preferably, the electrically conductive fluid is an aqueous solution of an electrolyte and more preferably water.

Preferably, the flow of water from the reservoir down to the probe tips is regulated by a hand operated lever in tubing below the reservoir and in a fluid path between the reservoir and the probes.

The invention, according to another aspect includes a ground-contacting, earthing device attached or incorporated with the bottom of probes to discharge static electricity which generates interference with test readings.

Preferably, the ground-contacting, earthing device is a spike of metal, such as stainless steel and projects beyond and slightly below the bottom of the probe pole.

Preferably, the spike is in the form of a rsilient member, such as a spring which makes an electrically conductive connection between the probe housing and the ground to earth static electricity, generated by wind and rubbing on clothes of an operator causing spurious readings on a meter by electrical interference.

Preferably, at least one of the probes contains a microswitch assembly incorporated within the handle of a probe pole, the microswitch being closed by pressure upon the handle by an operator placing the pole upon the ground and opened when an operator lifts the pole up from the ground, whereby a signal receiver meter is in the de-activated position when the pole is lifted off the ground.

The invention, according to one aspect provides apparatus for detecting protective coating defects in underground pipelines, cables or the like, buried under high electrical resistance ground, the apparatus comprising two probe poles with earthing spikes, a meter unit, including a microvolt metering device, a current interruptor, a back pack containing a water supply fluidly connected to a water

path to feed tips of the probe poles for increased conductivity thereof, a microswitch contained in the handle of at least one probe pole, means connecting the tip of the at least one pole to a signal receiver.

Preferably, the tip of each probe pole is removable and mutually interchangeable for access to fill holes for filling a hollow interior of the at least one pole with a copper sulphate solution around a copper tube to act as a reference electrode in the at least one pole.

Preferably, there is a microswitch in the handle of both probe poles and a copper/copper sulphate solution reference electrode within the hollow interior of each pole and the copper tube is also used to convey an electrically conductive fluid such as water from the reservoir down to each pole probe tip.

A non-limitative example of a practical arrangement of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a perspective view showing use of the type of apparatus of the invention carried by an operator at a test site over a buried pipeline with a coating defect.

Figure 2 is a schematic partial view of the handle top portion of a probe pole incorporating a microswitch.

Figure 3 is a schematic view of a half cell assembly with earth spike for one of the probe poles.

Figure 4 is a schematic partial diagram of the valve in a conduit for conveying conductive fluid from the reservoir to the probe poles.

Figure 5 is a schematic diagram of the apparatus of the invention is use on location.

Figure 6 is a block diagram showing connection of the components of the apparatus of the present invention, when in use.

Referring to the drawings, there is shown in Figure 1, apparatus for detecting areas suspectible to corrosion due to protective coating breakdown on underground pipelines using DC current voltage gradient surveys at such locations, particularly under high electrical resistance bitumen/asphalt surfaces. The apparatus includes two probe poles comprising right hand pole 10 and left hand pole 11, both of tubular construction from fibreglass reinforced resin, a microvolt metering device 12, a back pack 13, containing a reservoir of conductive fluid, such as an aqueous liquid, preferably water to supply through tubing 14 and side entry quick-release connection fitting 15, a water path down through the probe poles interior onto the tips via tube 16 (Fig. 2), the tips being designated 17, 18 for increased electrical conductivity of the tips. The right hand probe pole shown in Figure 2 of the drawings, the handle 19 is spring-loaded, via spring 20 and incorporates a microswitch 21 which connects the probe pole handle to a meter via the cable 22. The microswitch operates when an operator pushes the handle with the tip in contact with the ground, so that the contact 23, under the microswitch contacts the contact switch 24. The meter is operational via cable 22 to the meter when the microswitch contacts are closed. The microswitch operates as a make/break mechanism to break the circuit for easier operation when the probes are lifted up from the ground, whereupon the meter reads dead centre. Figure 2 also shows a side cable entry mounting for the connecting cable from the meter to the probe.. The readout from the probe pole sensor tip to the receiver is transmitted via cable 25, mounted in the pole to a multi-pin plug 26, this arrangement is more convenient in some circumstances to the probe top or handle entry arrangement, shown in Figure 1.

Referring to Figure 3 of the drawings, there is shown assembled in the right-hand probe pole a reference electrode comprising a central copper tube 27, passing

through a chamber 28 which, when in use is filled with an aqueous saturated solution of copper sulphate to form a Cu/CuSO4 reference electrode.

Referring to Figure 4, control of the flow of conductive fluid, such as water from the reservoir through the tube 27 is achieved by the hand-operated valve 29. At the base of the probe, the tube 27 is seated in a NYLON probe head 29a, aqueous conductive fluid, such as water flows down the tube and through a drilled channel in the NYLON head to the outer surface - the water flows over the head onto the porous plug which is screwed onto the base of the NYLON head. A liquid seal between the reference electrode, NYLON probe head and porous plug tip 29b is achieved by the O-ring seals 30 and 31.

An earth-grounding spike 32, fabricated from a conductive material such as metal, preferably stainless steel with a spiral spring 33 is fixed to the base of the probe pole. The probe end of the spike is coiled around the threaded NYLON porous plug holder which screws into the NYLON head. Pressure contact between the ground and the grounding spike is thus maintained.

When assembled for use, the liquid feed back pack and earthing spike of the invention are adapted to be incorporated into equipment for locating protective coating defects in buried pipelines, the probes being electrically connected to a) a microvolt metering device incorporating a meter which is a centre zero analogue voltmeter with selectable impedences of 100 and 1000 megohms, the device having a function control, range selector and impedence switch for selecting sensitivity.

b) a crystal control type signal generator current interruptor is used for signal injection, the interruptor has a battery, terminals for cable connections and on/off switch and a flashing signal. The pulsed signal to the structure is easily recognised by the meter which detects the pulsing voltage gradients at coating

defects whilst being unaffected by background interference and static.

c) Power supply is preferably an internal 12 volt sealed lead acid gel rechargeable battery. The probes are used as voltage comparators to detect voltage gradients of direct current flow between the probes.

Referring to Figures 5 and 6 of the drawings, to conduct a survey along a pipeline for detection of a protective coating defect, the current interruptor is set up at an existing cathodic protection impressed current unit, or an equivalent temporary system. The signal magnitude is checked by measuring on/off potentials at the nearest point to the impressed current system - a 500-600 millivolt shift is typical. Next the operation of the euipment is checked by placing one pole with the probe tip in contact with the ground surface and with other pole probe in contact with a pipe connection at a cathodic protection test station. Current flowing to the probe will be indicated by the euipment. Surveying is commenced with one probe over the line of the pipe and with the other set laterally. When approaching a defect, a polarity shift will be indicated by a deflection of the needle of the meter from mid point, or dead centre. The directional polarity of the meter will indicate the vicinity of the coating defect. Detecting the mid-point or centering the meter is achieved by placing the probes apart and measuring a succession of potential drops from the defect epi-centre to remote earth at right angles to the pipeline. The over the line to remote earth potential is the sum of the potential drops. The electrodes are placed at 2 or 3 different locations to confirm the validity of the defect indications and locations. Probes placed across voltage gradient lines will indicate a pulsed voltage deflection on the meter. Probes placed along equipotential lines will result in the meter nulling and tracing of voltage gradients will locate the defect epi-centre.

The invention quickly detects coating defects at specific locations with a voltmeter utilizing pulsing signals to detect D.C. voltage gradients. Readings taken at the defects to remote earth together with measured signal magnitudes enable a factor called percentage IR to be calculated. The percentage IR is a permanent benchmark signal factor which also gives an indication of the defect size and the possibility for corrosion to occur. Pipeline owners are thus able to determine if coating repairs should be undertaken, or alternatively, other measures are necessary.

The claims defining the invention are as follows:

1. Apparatus for locating protective coating defects in underground pipelines, cables or the like, buried under high resistance ground, the apparatus comprising a pair of hand probes for measuring signals in ground created by an injected, pulsed signal applied thereto, the probes being adapted to be placed by an operator on the ground above and on either side of a pipeline, cable or the like, the probes being electrically, operatively connected to a receiver and being fluidly connected to a reservoir containing an electrically conductive fluid fed to each probe via a water path whereby the electrically conductive fluid is conveyed to the tips of the probes to increase the conductivity thereof, when the probes are in contact with the ground.

2. Apparatus according to claim 1, wherein the electrically conductive fluid is an aqueous solution of an electrolyte.

3. Apparatus according to claim 1 or 2, wherein the electrically conductive fluid is water.

4. Apparatus according to any preceding claim wherein the flow of the electrically conductive fluid or water is regulated by a hand operated lever in tubing below the reservoir in a fluid path between the reservoir and the probes.

5. Apparatus according to any preceding claim which includes a ground-contacting earthing device attached to or incorporated with the bottom of at least one probe to discharge static electricity which generates interference in test readings.

6. Apparatus according to claim 5, wherein the device is a spike of metal projecting beyond and slightly below the bottom of the probe pole.

7. Apparatus according to claim 6, wherein the spike is of stainless steel.

8. Apparatus according to any one of claims 5 to 7, wherein the spike is in the form of a resilient member,

such as a spring which makes an electrically conductive connection between the probe housing and the ground to earth static electrically generated by wind and rubbing on clothes of an operator causing spurious readings on a meter, by electrical interference.

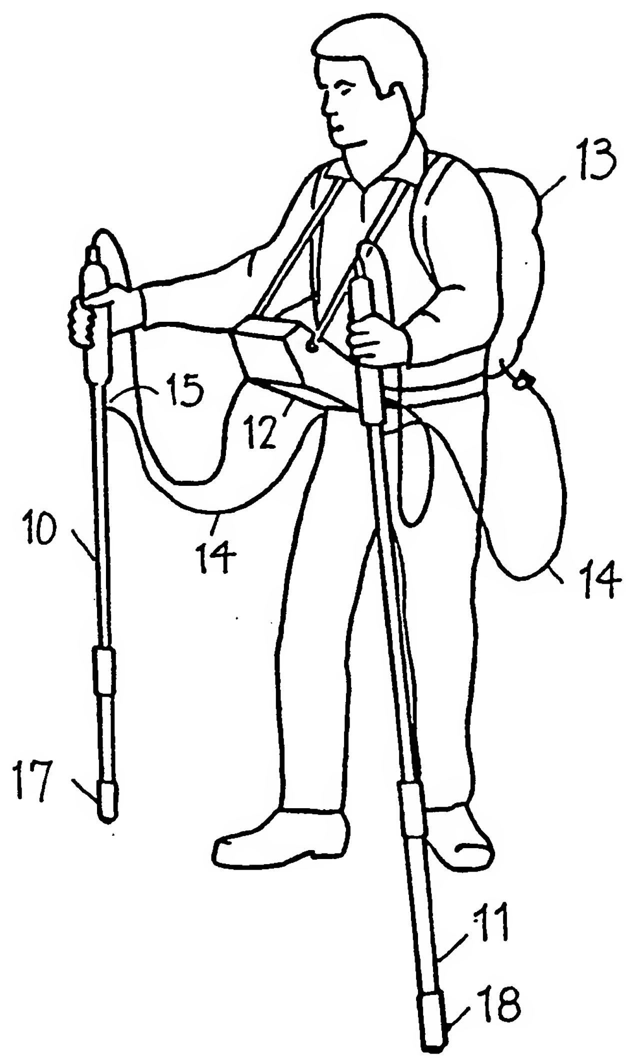
9. Apparatus according to any preceding claim wherein at least one of the probes contains a microswitch within the handle of a probe pole, the microswitch being closed by pressure upon the handle by an operator placing the pole upon the gound and opened when an operator lifts the pole from the ground, whereby a signal receiver meter is deactivated when the pole is lifted off the ground.

10. Apparatus for detecting protective coating defects in underground pipelines or cables under high electrical resistance ground, which apparatus detects DC voltage gradients through pulsing signals in soil underneath said ground, the apparatus comprising two probe poles with earthing spikes, a meter unit including a microvolt metering device, a current interruptor, a back pack containing a water supply fluidly connected to a water path to feed tips of the probe poles for increased conductivity thereof, a microswitch contained in the handles of at least one probe pole means connecting the tip of at least one pole to a signal receiver.

11. Apparatus according to claim 9, wherein the tip of each probe pole is removable and mutually interchangeable for access to fill holes for filling a hollow interior of the at least one pole with a copper sulphate solution around a copper tube to act as a reference electrode in the at least one pole.

12. Apparatus according to claim 10 or 11, wherein there is a microswitch in the handle of both probe poles and a copper/copper sulphate solution reference electrode within the hollow interior of each pole and the copper tube is also used to convey an electrically conductive fluid, such as water from the reservoir down to each pole probe tip.

FIG. 1



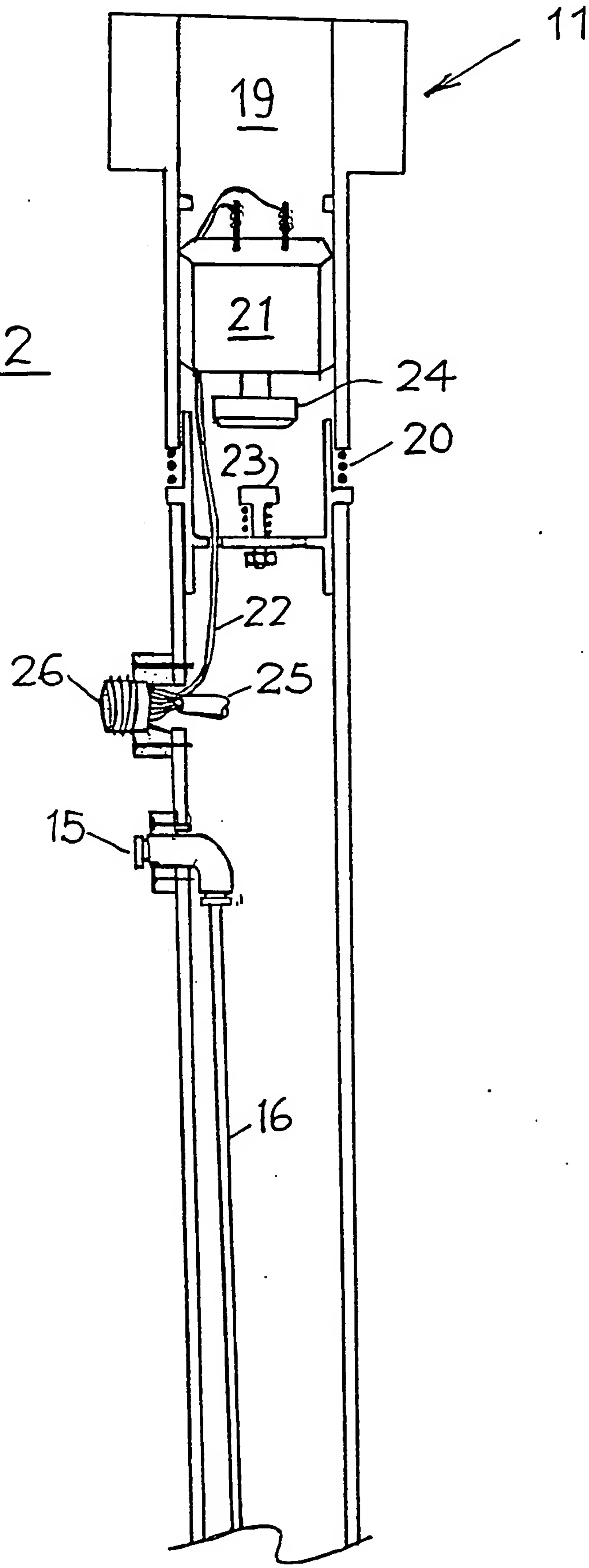


FIG. 2

FIG. 3

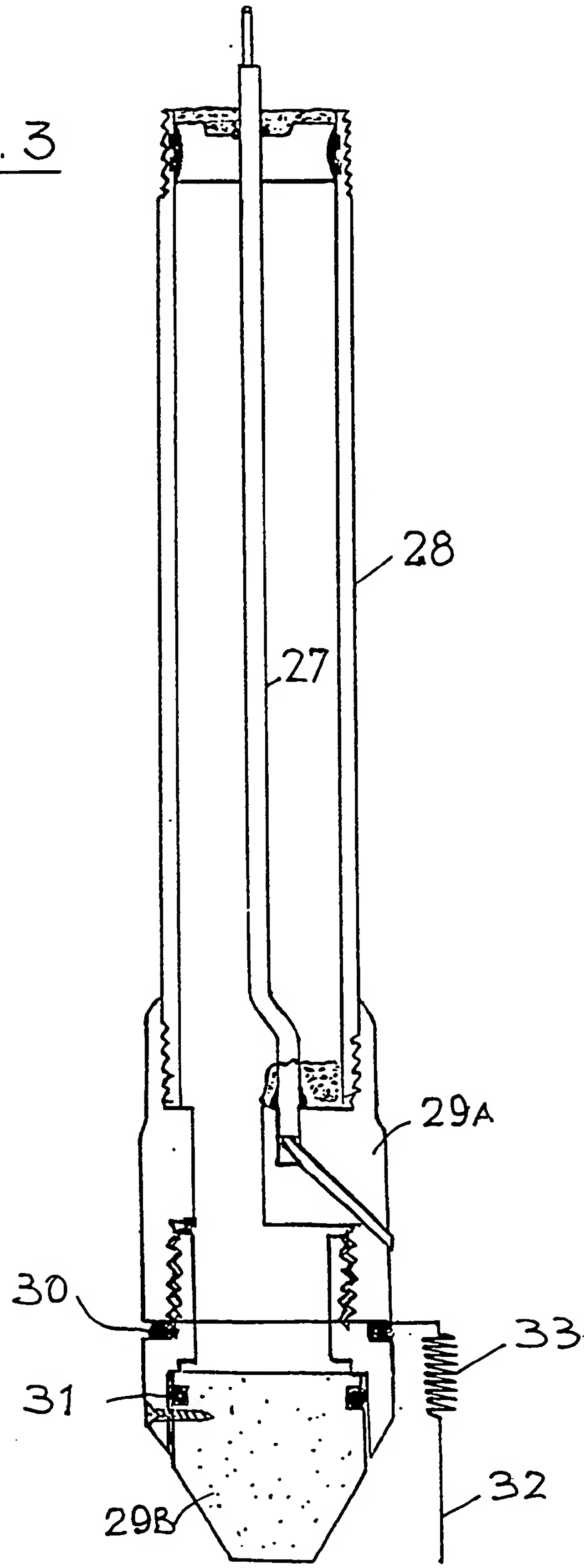


FIG. 4

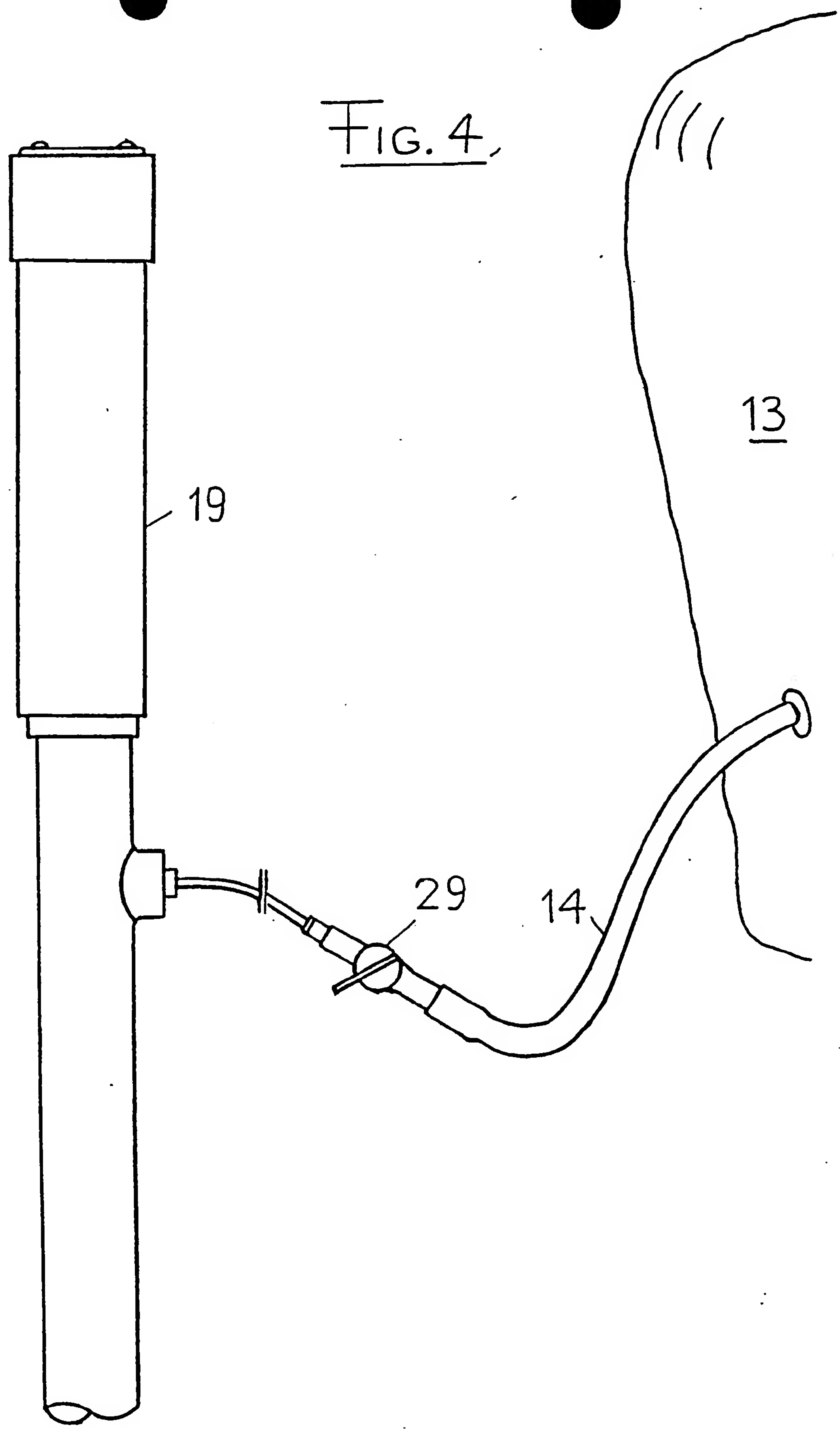
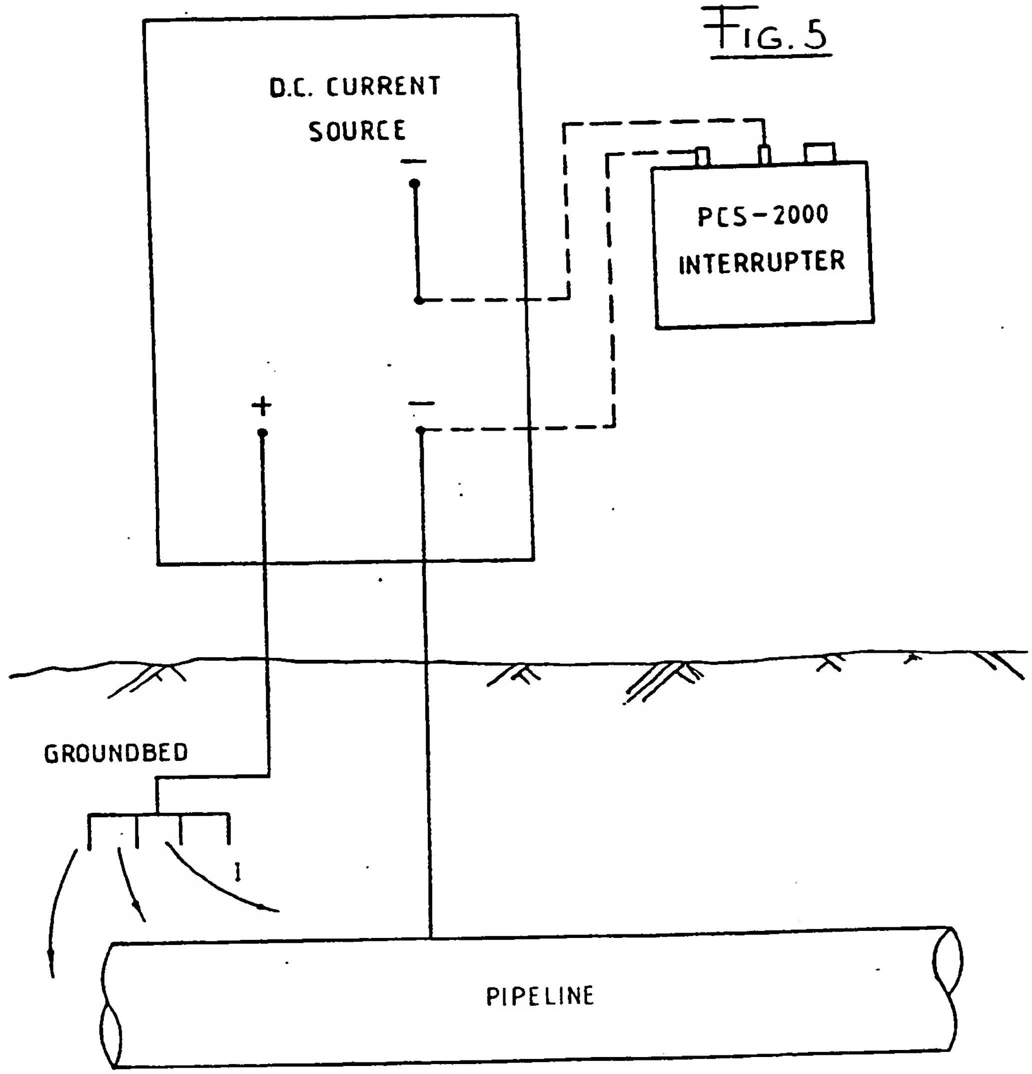


FIG. 5



Interrupter set-up to inject signal

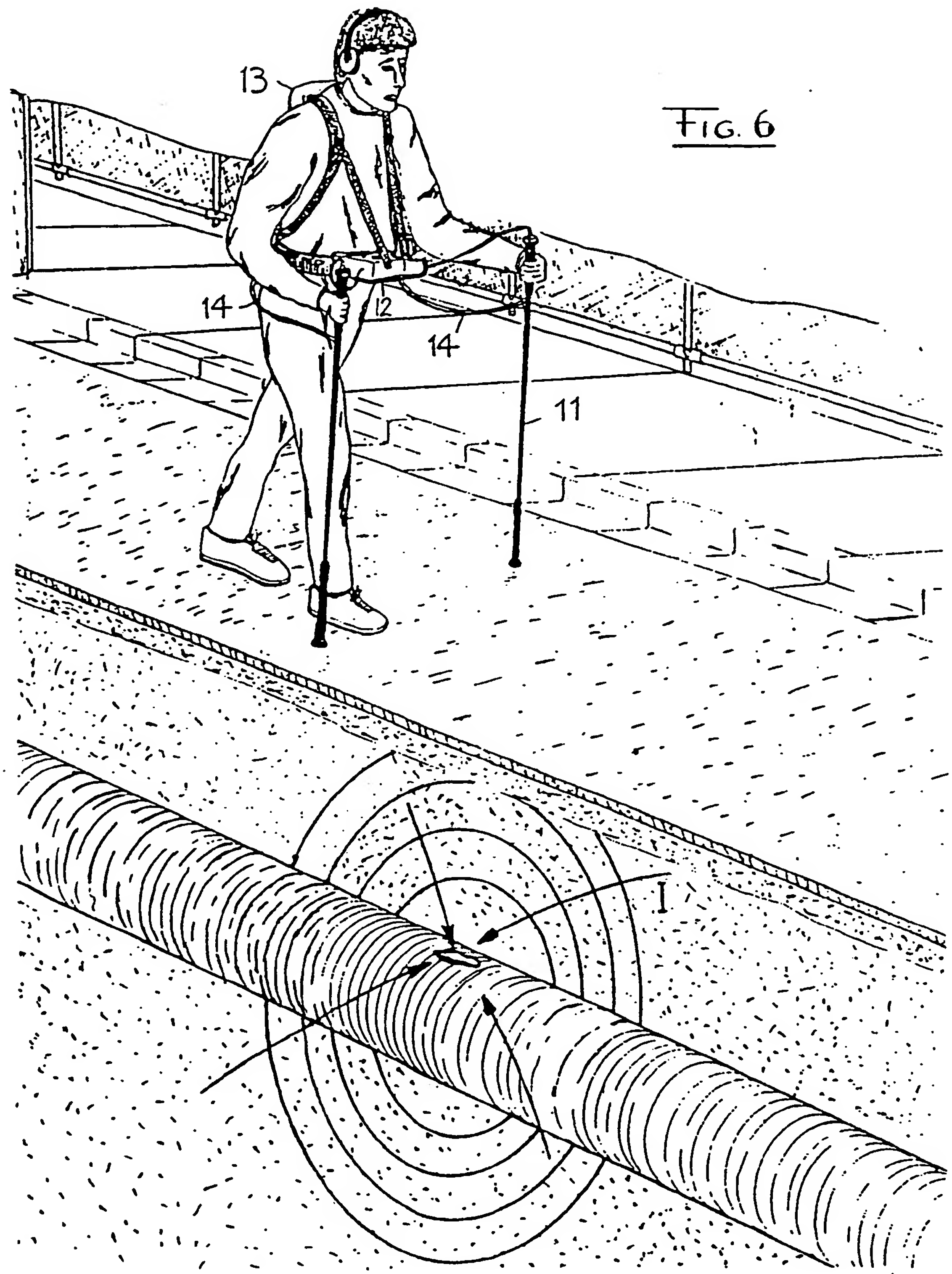


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 88/00145

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{4} G01N 27/20, G01R 27/20

II. FIELDS SEARCHED

Minimum Documentation Searched *

Classification System	Classification Symbols
IPC : G01N 27/20, G01R 27/20	

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *

AU : IPC as above, G01N 27/04, 33/24, 27/26

III. DOCUMENTS CONSIDERED TO BE RELEVANT *

Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages **	Relevant to Claim No. **
X	GB,A, 2078963 (HARCO CORPORATION) 13 January 1982 (13.01.82)	(1-4)
A	US,A, 3735249 (STOLL) 22 May 1973 (22.05.73)	
A	GB,B, 843419(SUPERIOR OIL COMPANY) 4 August 1960 (04.08.60)	
A	US,A, 2105247 (JAKOSKY) 11 January 1938 (11.01.38)	
A	US,A, 4151458(SEAGER) 24 April 1979 (24.04.79)	
A	Patent Abstracts of Japan, P545, page 18, JP,A, 61-210935(NIPPON STEEL) 19 September 1986 (19.09.86)	
A	Patent Abstracts of Japan, P493, page 103, JP,A, 61-83951(NIPPON STEEL) 28 April 1986 (28.04.86)	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9 August 1988 (09.08.88)	(29.08.88) 29 AUGUST 1988
International Searching Authority	**Signature of Authorized Officer**
AUSTRALIAN PATENT OFFICE	R. MURRAY

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/AU 88/00145

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Patent Document Cited in Search Report	Patent Family Members
GB 2078963	US 4388594
US 4151458	CA 1032223

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